

The VLBI morphology of M 81* at 43 GHz

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The radio source M 81* at the core of the nearby spiral galaxy M 81 is a low-luminosity active galactic nucleus. The close distance of 3.63 Mpc allows its morphology to be studied in great detail. Here we present preliminary results from continuum $\lambda 7$ mm VLBI observations of its core, using phase-referencing techniques. These observations set constraints on the size of M 81* at this frequency and enable us to test the frequency dependence on its physical properties.

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1. Introduction

At the heart of the nearby galaxy M 81 (B0951+693, J0955+6903, NGC 3031; $D = 3.63$ Mpc), the low-luminosity ($10^{37.5}$ erg s $^{-1}$) radio source M 81* is one of the closest active galactic nuclei (AGN). This object is four orders of magnitude brighter than Sgr A*, but has similar shape and polarization properties. M 81* shows a stationary feature in its structure with a jet to the northeast (seen at $\lambda 3.6$ cm; [1]). Its size follows the law $\theta \propto \nu^{-0.8}$ between 2.3 GHz and 22 GHz. It shows also a frequency-dependent orientation with its position angle (P.A) varying from $\sim 40^\circ$ at 22 GHz to $\sim 75^\circ$ at 2.3 GHz [2]. M 81* is variable at all wavebands, and presents relativistic X-ray iron lines at X-rays [1].

2. Observations and data analysis

We observed M 81* on September 13, 2002 with the complete Very Long Baseline Array at a frequency of 43 GHz ($\lambda 7$ mm). Observations were performed in phase-referencing mode, using the BL Lac object B0954+658 (J0958+6533; $z=0.368$), 34 arcmin apart on the sky. After calibration, the first FRING run (NL was used as reference antenna) on the target source provided a 65% failure in the overall solutions, while an 80% of successful fringe detection were obtained for the reference source. Hybrid mapping was performed for the calibrator source using DIFMAP. The resulting self-calibration solutions for the amplitude were applied to the M 81* data back in AIPS. A run of IMAGR in AIPS was performed, yielding an image. The CLEAN table of those was used as input in FRING to make structure-free delay and rate solutions. Using these values we restricted the search windows for delay and rate in M 81*, and we applied FRING again, providing very satisfactory results. We then were able to perform a hybrid map of M 81*, shown in Figure 1. Our image provides hints of extended emission to the north-east, in agreement with [1].

3. Discussion

We also model fitted the visibility data of M 81* with a Gaussian elliptical function. The source has an elliptical shape extended in the north-east–south-west direction. The major axis of the function is of $93 \pm 1 \mu\text{as}$, with an axis ratio of 0.3 ± 0.1 . We used the model fitted size of our target source to compare it with earlier measurements. A power-law fit to the sizes as a function of frequency, (including the epoch-averaged measurements by [3, 4]) together with our measurement shows a dependence of $\theta \propto \nu^{-0.88 \pm 0.05}$. These results are compatible with the ones previously reported by [2].

Our observations have resulted in the detection of M 81* at the shortest wavelength performed with VLBI so far. Further observations are needed to discern the nature of the jet in M 81*. Future monitoring observations could also trace any structural changes and/or proper motions in the jet.

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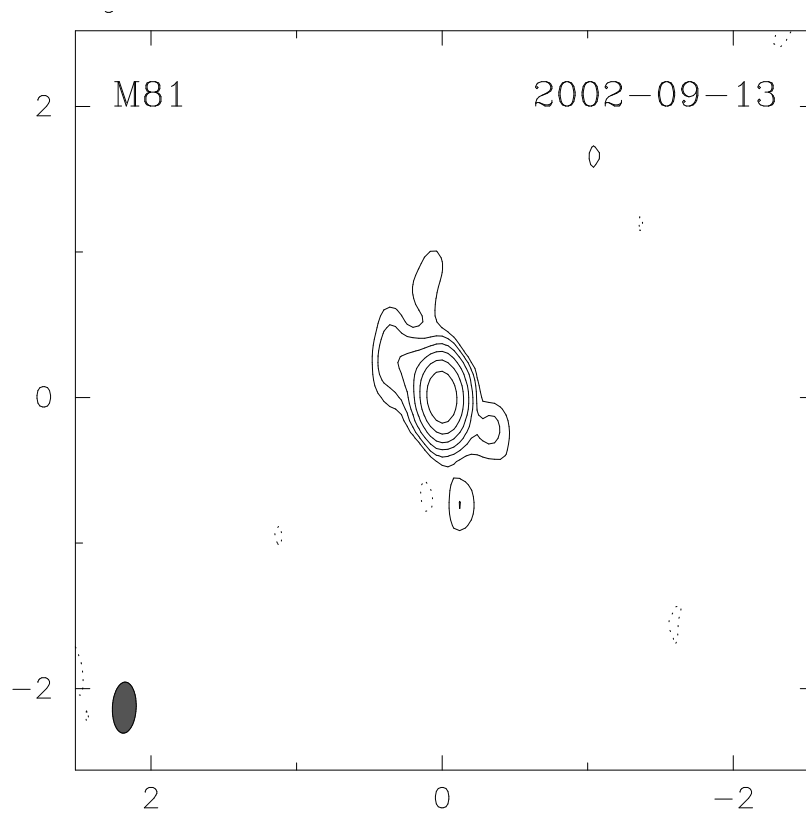


Figure 1: Hybrid contour map of M81* from the self-calibrated data set (see Text). The lowest contour is of $1.57\text{ mJy beam}^{-1}$. The peak of brightness is of $98.5\text{ mJy beam}^{-1}$. The beam size, shown at the bottom, left, is of $0.351 \times 0.164\text{ mas}$, in P.A. 2.6° .

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